

WHAT IS CLAIMED IS:

1. A double feed detecting apparatus  
comprising:

ultrasonic transmitting means installed on one  
5 side of a transport path for a sheet material for  
transmitting an ultrasonic toward the sheet material;

ultrasonic receiving means installed on the  
other side of the transport path for the sheet  
material for receiving the ultrasonic transmitted by  
10 said ultrasonic transmitting means and outputting a  
received ultrasonic signal;

first double feed determining means for  
determining whether double feed or not in accordance  
with an amplitude of the received ultrasonic signal  
15 output by said ultrasonic receiving means; and

second double feed determining means for  
determining whether double feed or not in accordance  
with a phase of the received ultrasonic signal output  
by said ultrasonic receiving means.

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2. A double feed detecting apparatus according  
to Claim 1, wherein said first double feed  
determining means calculates an amplitude of a noise  
signal received by said ultrasonic receiving means  
25 while said ultrasonic transmitting means does not  
transmit the ultrasonic, and determines whether  
double feed or not on the basis of a change in the

calculated amplitude of the received ultrasonic signal and the amplitude of the noise signal.

3. A double feed detecting apparatus according  
5 to Claim 1, further comprising sampling means for  
foreseeing timing at which the amplitude of the  
received ultrasonic signal becomes maximum, from a  
distance from said ultrasonic transmitting means to  
said ultrasonic receiving means, and a propagation  
10 speed of the ultrasonic, and sampling a plurality of  
the received ultrasonic signals at the foreseen  
timing, wherein said first double feed determining  
means and said second double feed determining means  
process the received ultrasonic signals after sampled  
15 by said sampling means.

4. A double feed detecting apparatus according  
to Claim 2, wherein said first double feed  
determining means calculates the amplitude of the  
20 noise signal immediately before said ultrasonic  
transmitting means transmits the ultrasonic.

5. A double feed detecting apparatus according  
to Claim 3, wherein said sampling means executes the  
25 sampling of the received ultrasonic signal a  
plurality of times, and averages data corresponding  
to the plurality of times of sampling of the received

ultrasonic signal by sampling point.

6. A double feed detecting apparatus according to Claim 1, further comprising:

5        phase information obtaining means for obtaining information of a phase of the received ultrasonic signal in a state in which the amplitude of the received ultrasonic signal output by said ultrasonic receiving means becomes maximum; and

10        basic phase information holding means for holding and storing therein the information of a basic phase with the phase of the received ultrasonic signal obtained by said phase information obtaining means when said ultrasonic receiving means has  
15        directly received the ultrasonic from said ultrasonic transmitting means as the basic phase,

      wherein said second double feed determining means compares a phase for comparison which is the phase of the received ultrasonic signal obtained by  
20        said phase information obtaining means when said ultrasonic receiving means has received from said ultrasonic transmitting means the ultrasonic transmitted through the sheet material with the basic phase held by said basic phase information holding  
25        means to thereby determine whether double feed or not.

7. A double feed detecting apparatus according

to Claim 6, wherein said basic phase information holding means renews the information of the basic phase each time the sheet material is transported.

5           8. A double feed detecting apparatus according to Claim 7, further comprising:

          signal amplifying means for amplifying the received ultrasonic signal output by said ultrasonic receiving means at plural kinds of amplification  
10 factors; and

          information holding timing forming means for forming a timing signal for controlling timing at which said phase information obtaining means obtains the information of the basic phase, on the basis of a  
15 change in the received ultrasonic signal after first amplification in which said signal amplifying means has amplifies the received ultrasonic signal within a range in which it is not saturated,

          wherein said phase information obtaining means  
20 obtains the information of the basic phase from the received ultrasonic signal after second amplification in which said signal amplifying means has amplified the received ultrasonic signal so as to be saturated, in correspondence with the timing signal, and said  
25 second double feed determining means compares the basic phase and the phase for comparison of the received ultrasonic signal after the second

amplification in which said signal amplifying means has amplified the received ultrasonic signal to thereby effect the determination of double feed.

5           9. A double feed detecting apparatus according to Claim 8, wherein said signal amplifying means amplifies the received ultrasonic signal at plural kinds of amplification factors by a construction in which a plurality of signal amplifying circuits are  
10 series-connected and each connection point is output.

          10. A double feed detecting apparatus according to Claim 8, wherein said signal amplifying means amplifies the received ultrasonic signal at plural  
15 kinds of amplification factors by a construction in which signal amplifying circuits of plural kinds of amplification factors are parallel-connected and output is effected from each of the signal amplifying circuits.

20           11. A double feed detecting method using a double feed detecting apparatus provided with ultrasonic transmitting means installed on one side of a transport path for a sheet material for  
25 transmitting an ultrasonic toward the sheet material, and ultrasonic receiving means installed on the other side of the transport path for the sheet material for

receiving said ultrasonic transmitted by said ultrasonic transmitting means and outputting a received ultrasonic signal, said method comprising:

5 a first step of calculating an amplitude of the received ultrasonic signal output by said ultrasonic receiving means;

a second step of calculating an amplitude of a noise signal received by said ultrasonic receiving means while said ultrasonic transmitting means does  
10 not transmit the ultrasonic;

a third step of determining whether double feed or not on the basis of a change in the amplitude of the received ultrasonic signal calculated at said first step, and a change in the amplitude of the  
15 noise signal calculated at said second step; and

a fourth step of detecting a phase change in the received ultrasonic signal to determine whether double feed or not on the basis of the detected phase change.

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12. A computer-readable recording medium having recorded therein a program for a double feed detecting apparatus provided with ultrasonic transmitting means installed on one side of a  
25 transport path for a sheet material for transmitting an ultrasonic toward the sheet material, and ultrasonic receiving means installed on the other

side of the transport path for the sheet material for receiving the ultrasonic transmitted by said ultrasonic transmitting means and outputting a received ultrasonic signal, said recording medium comprising:

a first step of calculating an amplitude of the received ultrasonic signal output by said ultrasonic receiving means;

a second step of calculating an amplitude of a noise signal received by said ultrasonic receiving means while said ultrasonic transmitting means does not transmit the ultrasonic;

a third step of determining whether double feed or not on the basis of a change in the amplitude of the received ultrasonic signal calculated at said first step, and a change in the amplitude of the noise signal calculated at said second step; and

a fourth step of detecting a phase change in the received ultrasonic signal to determine whether double feed or not on the basis of the detected phase change.

13. A double feed detecting apparatus comprising:

ultrasonic transmitting means installed on one side of a transport path for a sheet material for transmitting an ultrasonic toward the sheet material;

ultrasonic receiving means installed on the other side of the transport path for the sheet material for receiving said ultrasonic and outputting a received ultrasonic signal;

5 control means for controlling an obtaining timing of the received ultrasonic signal and/or a characteristic of the ultrasonic transmitted by said ultrasonic transmitting means to adjust an amplitude of the received ultrasonic signal output by said  
10 ultrasonic receiving means; and

signal analyzing means for analyzing whether double feed or not on the basis of a change in the amplitude of the received ultrasonic signal output by said ultrasonic receiving means which has been  
15 adjusted by said control means.

14. A double feed detecting apparatus according to Claim 13, wherein the ultrasonic transmitted by said ultrasonic transmitting means is a burst-wave,  
20 and the characteristic of the ultrasonic transmitted by said ultrasonic transmitting means which is controlled by said control means is a pulse number in the burst-wave of the ultrasonic.

25 15. A double feed detecting apparatus according to Claim 13, wherein the characteristic of the ultrasonic transmitted by said ultrasonic



transmitting means which is controlled by said control means is a pulse amplitude of the ultrasonic.

16. A double feed detecting apparatus according to Claim 13, wherein the characteristic of the ultrasonic transmitted by said ultrasonic transmitting means which is controlled by said control means is a frequency of the ultrasonic.

17. A double feed detecting apparatus according to Claim 13, wherein the ultrasonic transmitted by said ultrasonic transmitting means is a burst-wave, and the obtaining timing of the received ultrasonic signal controlled by said control means is timing for obtaining the received ultrasonic signal assuming a desired amplitude by the utilization of the fact that the amplitude of the received ultrasonic signal by the burst-wave of the ultrasonic is increased or decreased by the lapse of time.

18. A double feed detecting apparatus according to Claim 13, wherein the ultrasonic transmitted by said ultrasonic transmitting means is a burst-wave, and the characteristic of the ultrasonic transmitted by said ultrasonic transmitting means which is controlled by said control means is one or a combination of a pulse number, a pulse amplitude and

a frequency in the burst-wave of the ultrasonic, and the obtaining timing of the received ultrasonic signal controlled by said control means is timing for obtaining the received ultrasonic signal assuming a  
5 desired amplitude by the utilization of the fact that the amplitude of the received ultrasonic signal by the burst-wave of the ultrasonic is increased or decreased by the lapse of time.

10 19. A double feed detecting apparatus according to Claim 13, wherein when a plurality of the sheet materials are being continuously transported at a predetermined interval, said control means performs control for adjusting the amplitude of the received  
15 ultrasonic signal before each sheet material passes between said ultrasonic transmitting means and said ultrasonic receiving means.

20 20. A double feed detecting apparatus comprising:  
ultrasonic transmitting means installed on one side of a transport path for a sheet material for transmitting an ultrasonic of a burst-wave toward the sheet material at an arbitrary time interval;  
25 ultrasonic receiving means installed on the other side of the transport path for the sheet material for receiving the ultrasonic transmitted by

said ultrasonic transmitting means and outputting a received ultrasonic signal;

signal analyzing means for analyzing whether double feed or not and a change in a convergence time  
5 required for the received ultrasonic signal output by said ultrasonic receiving means to be converged, on the basis of a change in an amplitude of the received ultrasonic signal output by said ultrasonic receiving means; and

10 control means for controlling said ultrasonic transmitting means so as to change the time interval at which the ultrasonic is transmitted, in accordance with the convergence time analyzed by said signal analyzing means.

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21. A double feed detecting apparatus according to Claim 20, wherein said signal analyzing means obtains an amplitude value during a maximum amplitude of the received ultrasonic signal, and calculates the  
20 convergence time on the basis of the obtained amplitude value.

22. A double feed detecting apparatus according to Claim 20, wherein said signal analyzing means  
25 utilizes a threshold value of an amplitude for judging the convergence of the received ultrasonic signal to calculate the convergence time from a time

from after the reception of the received ultrasonic signal is started until the amplitude of the received ultrasonic signal becomes equal to or less than the threshold value.

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23. A double feed detecting method using a double feed detecting apparatus provided with ultrasonic transmitting means installed on one side of a transport path for a sheet material for  
10 transmitting an ultrasonic toward the sheet material, and ultrasonic receiving means installed on the other side of the transport path for the sheet material for receiving the ultrasonic transmitted by said ultrasonic transmitting means and outputting a  
15 received ultrasonic signal, said method comprising:

a first step of controlling an obtaining timing of the received ultrasonic signal and/or a characteristic of the ultrasonic transmitted by said ultrasonic transmitting means to adjust an amplitude  
20 of the received ultrasonic signal output by said ultrasonic receiving means; and

a second step of analyzing whether double feed or not on the basis of a change in the amplitude of the received ultrasonic signal output by said  
25 ultrasonic receiving means which has been adjusted by said first step.

24. A computer-readable recording medium having recorded therein a program for a double feed detecting apparatus provided with ultrasonic transmitting means installed on one side of a transport path for a sheet material for transmitting an ultrasonic toward the sheet material, and ultrasonic receiving means installed on the other side of the transport path for the sheet material for receiving the ultrasonic transmitted by said ultrasonic transmitting means and outputting a received ultrasonic signal, said recording medium comprising:

a first step of controlling the obtaining timing of the received ultrasonic signal and/or a characteristic of the ultrasonic transmitted by said ultrasonic transmitting means to adjust an amplitude of the received ultrasonic signal output by said ultrasonic receiving means; and

a second step of analyzing whether double feed or not on the basis of a change in the amplitude of the received ultrasonic signal output by said ultrasonic receiving means which has been adjusted by said first step.